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⑤④ Material for insulations and sheaths of electric power cables, and electric power cables provided with insulations and sheaths made of said material.

⑤⑦ The invention provides power cable insulations and sheaths and conductor coverings constituted from a compound based on a copolymer whose monomers are ethylene and an ester containing a double bond, magnesium hydroxide being present in said compound.

The invention refers, moreover, to cables provided with insulations and sheaths made from the above cited material.

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1 MATERIAL FOR INSULATIONS AND SHEATHS OF ELECTRIC POWER
CABLES, AND ELECTRIC POWER CABLES PROVIDED WITH INSULATIONS
AND SHEATHS MADE OF SAID MATERIAL

5 The present invention refers to a material for insulations
and/or sheaths of electric power cables, and it refers, more-
over, to electric power cables provided with an insulation
and/or a sheath made from the material which forms the
object of the present invention.

10

Moreover, the present invention refers to a material suited
for covering conductors and acting both as an insulation and
a sheath, and to conductors provided with said covering.

15 One problem that rises in electric power cables in general
is that of having an insulation and/or a sheath or a covering
both as an insulation and a sheath, which is endowed with
non-flame-propagating characteristics in the presence of a
fire, and which possesses besides this characteristic, also
20 the properties of emitting fumes that are as transparent as
possible, and which does not originate any poisonous gases
during a fire.

For solving the above problem in known cables there was
25 taken recourse to the presence of aluminium-hydroxide in
the compound that forms an insulation, a sheath or a cover-
ing acting both as an insulation and a sheath.

These known cables do not solve, in any really efficacious
30 manner, the problem of not propagating the flames, should
there be a break out of fire, although some positive results
have duly been obtained as far as regards the forming of
transparent fumes and the absence of toxic gases.

35

- 1 One aim of the present invention is to solve in an efficient way and with regard to the materials used for forming insulations, sheaths and coverings that serve as insulations and sheaths for electric power cables, the problem of
- 5 preventing any flame-propagation, with improving at the same time the properties of emitting transparent fumes and of not emitting toxic gases, while also improving the dielectric properties of said materials themselves.
- 10 Consequently, it is also one aim of the present invention to solve in electric power cables provided with insulations and/or sheaths or coverings that act as insulations and sheaths, the problem of preventing, in an efficient manner, any flame-propagation, with improving at the same time
- 15 the capacity for emitting only transparent fumes, with avoiding any formation of toxic gases, and also with improving the dielectric properties of the insulations and of the coverings acting as insulations and sheaths for said cables.
- 20 What forms one object of the present invention is a material for insulations and sheaths of electric cables and for conductor coverings that serve both as an insulation and a sheath, characterized by the fact of comprising a compound
- 25 based on a copolymer, the monomers of which are ethylene and an ester containing at least one double bond, in which compound there is present magnesium hydroxide as one component thereof.
- 30 Another object of the present invention is an electric cable comprising a conductor and at least one insulation or a covering serving as an insulation and a sheath, characterized by the fact that said insulation or covering is a copolymer base compound, the monomers of which are ethylene and an
- 35 ester containing a double bond, which compound has magnesium

1 hydroxide as one component thereof.

The present invention will be better understood from the following detailed description, made solely by way of non
5 limiting example, with respect to the figure of the attached drawing, wherein there is shown in a perspective view (with parts removed) a length of an electric cable according to the invention. According to the more general idea of solution of the present invention, it comprises a
10 material for the formation of insulations and/or sheaths and of coverings serving both as an insulation and a sheath of electric cables consisting of a compound based on a copolymer, the monomers of which are ethylene and an ester containing at least one double bond, in which compound
15 there is present magnesium hydroxide as a main component hereof.

Still according to the more general idea of solution of the present invention, it comprises an electric cable provided
20 with an insulation and/or a sheath or a covering that serves both as an insulation and a sheath, made from the above stated materials.

Moreover, still according to the more general idea of
25 solution of the present invention, the magnesium hydroxide being present in the compound for forming the insulation and sheath of electric cables and conductor coverings, is present in a quantity comprised between 75 and 300 parts by weight with respect to 100 parts by weight of the
30 polymer base of the compound.

In the figure there is shown in a perspective view a length of a cable according to the invention. As can be seen
35 in this figure, the cable comprises a conductor 1, for example, of copper or aluminium, around which there is

1 disposed a covering 2 serving the simultaneous purposes of an insulation and of a sheath, which covering 2 is made of a compound according to the invention.

5 The covering 2 of the cable is made of a compound based on a copolymer, the monomers of which are ethylene and an ester containing a double bond, such as, for example: ethylene vinyl acetate.

10 Another fundamental element of said compound forming the covering 2 is the presence in said compound of magnesium hydroxide, and in particular, magnesium hydroxide comprised between 75 and 300 parts by weight with respect to 100 parts by weight of the polymer base.

15 A compound that is particularly suited for forming the covering 2 of a cable according to the invention has the composition given herebelow:

	<u>PARTS BY WEIGHT</u>
20 ETHYLENE VINYL ACETATE	100
MAGNESIUM HYDROXIDE	170
CARBOIMIDE	3,8
VINYL TRIMETHOXY ETHOXYSILANE	1,8
STEARIC ACID	2,3
25 2-4 POLYMERIZED HYDROXY QUINOLINE	1,5
PARAFFIN WAX	2,3
DICUMYL PEROXIDE	3

30 With the compound for coverings serving simultaneously as an insulation and a sheath for electric power cables, according to the invention (which is listed hereabove just by way of example), there have been carried out experimental tests for pointing out its behaviour as regards its effective capacities of preventing flame propagation, of emitting more or less
35 transparent fumes during a fire, and moreover, for showing the dielectric characteristics of said material itself.

1 As far as concerns the insulations, the sheaths and the
coverings that serve simultaneously as an insulation and
a sheath of known cables, in the tests carried out, sub-
stantially identical compounds were used as in the
5 above given composition (which forms a particular embodiment
of the materials used according to the invention), except
for one difference only in that the said magnesium hydroxide
was replaced by an equal quantity of aluminium hydroxide.

10 TESTS FOR DETERMINING THE TRANSPARENCY OF THE FUMES

The tests for determining the transparency of the fumes were
performed according to the STANDARD 258-1976, set up by the
National Fire Protection Association (N.F.P.A.).

15

For carrying out these tests, square shaped test pieces
were prepared, having sides of 76,2 mm and a thickness of
3 mm, of materials used for insulations and sheaths of
electric cables according to the present invention, and of
20 materials used for the sheaths and insulations of known
cables.

25

The thus prepared test pieces were introduced into a testing
apparatus as the one described in the above cited N.F.P.A.
STANDARD.

30

The testing apparatus comprised a gas tight sealed parallel-
epiped chamber, inside of which there was present a support
for the test piece. In correspondence of said support there
were present six small burners, the flames of which were ob-
tained by combustion of an air and propane mixture.

35

Moreover, inside this tightly sealed parallelepiped chamber,
there was also present a device apt for supplying radiant
energy. Said device was constituted substantially by a ceramic
tube, inside of which there was placed a resistance supplied
with electric current.

1 Said parallelepiped chamber was provided on two of its
facing walls with sheets transparent to light in such a way
as to allow the passage of a luminous beam of light into the
chamber itself. Consequently, opposite to one of said walls
5 constituted by the sheets transparent to light, there was
foreseen a source of light having a predetermined intensity.
Whereas, in the correspondence of the other transparent to
light wall of the parallelepiped chamber, there was present
a photo meter apt for measuring the intensity of the light
10 incident on it (after traversing the parallelepiped chamber)
and the degree of intensity of said light is expressed as the
"specific optical density" of what is contained in the
chamber itself.

15 The performance of the various tests with the testing
apparatus (briefly described above) was duly carried out
according to the instructions set up by the STANDARD in
question i.e. according to the following modalities.
The test pieces were firstly dried for 24 hours at a
20 temperature of 60°C, and then conditioned by placing them in
an ambient having a room temperature of 23°C where the
relative humidity was of 50%. After the above preliminary
treatment the testing was commenced with each test piece
being introduced into the parallelepiped chamber, with
25 having the burners ignited and the device for supplying
the radiant energy working. Through the photo meter the
specific optical density of the fumes was noted, after
4 minutes from the start of the test. Also the maximum
specific optical density of the fumes was noted. The
30 average results of the tests are given in the Table here-
below:

1		D4	Dm	L.I.O.
5	Compound according to the invention used for conductor coverings serving both as insulation and sheath	10	100	31
10	Known compound used for conductor coverings serving both as insulation and sheath	20	150	31

Where:

D4 is the specific optical density of the fumes, after 4 minutes from the start of the test.

15 Dm is the maximum specific optical density of the fumes.

20 L.I.O. is the so called oxygen index that represents the minimum quantity of oxygen, in a mixture of oxygen and azote, that is required for permitting the combustion of a test piece, as defined by STANDARD-ASTM2863.

FLAME PROPAGATION RESISTANCE TEST

25 The tests for determining the resistance to flame propagation in the materials for insulations and/or sheaths of electric cables, and for conductor coverings serving both as an insulation and a sheath, according to the invention, as compared to known types of electric cable sheaths and
30 conductor coverings serving both as an insulation and a sheath, were carried out according to the following modalities set up in the STANDARD NF C32-070.

35 Test pieces were prepared of cables according to the invention and of known cables having a lenght of 1600 mm,

- 1 a copper conductor, having a cross section of $2,5 \text{ mm}^2$, and
a covering having a thickness of 1,2 mm.

5 A bundle of 70 cable lengths thus prepared was tied up together with iron wires and introduced into a testing cabin that was comprised of a parallelepiped shaped casing having a height of 2000 mm, a width of 600 mm, and a depth of 700 mm.

- 10 In the correspondence of the ceiling of the cabin, there was present an aspirator, while in correspondence of the lower part of the cabin, there were present air inlets. Inside the cabin, there was housed a metallic chimney into which the bundle of cable lengths to be tested was placed. Below
15 the chimney, there were present two butane gas burners, which were adjustable in such a way as to cause their flames to result tangentially to the bundle of the cable lengths, in correspondece of the base of the latter.

- 20 Moreover, at the chimney base, there was present an electric furnace. Said electric furnace in question had a potential power gradient that was capable of causing the temperature of a black body inserted into the furnace to rise, with having a heating rate in $^{\circ}\text{C}/\text{sec}$ corresponding to the formula
25 given herebelow:

$$\tau = \frac{T_{35} - T_5}{30}$$

- 30 Where:

- τ must be comprised between 3,2 and 3,4 $^{\circ}\text{C}/\text{sec}$.
 T_{35} is the furnace temperature, 35 sec. after starting time.
 35 T_5 is the furnace temperature, 5 sec. after starting time.

1 After the bundle of cable lengths to be tested had been intro-
duced into the testing cabin, the interior of the cabin it-
self was thermo regulated until a temperature of 15°C was
reached. Next, the two burners were ignited, and the furnace
5 was positioned in correspondence of the lower extremities of
the test pieces after the furnace itself had reached a
temperature comprised between 750°C and 900°C. The fan of
the aspirator was also switched on so as to cause a stream
of air having a rate of 120 m/min approx. Under these above
10 given conditions, the duration of the test was about 30
minutes, after which the burners and the electric furnace
were switched off.

15 The results obtained from the tests carried out, are as follows:

With the known materials for insulations and cable sheaths,
and with the known conductor coverings serving both as an
insulation and a sheath, after 4 (four) minutes from the
20 starting time of the test, the whole bundle of cable lengths
was found to be entirely burnt.

With the materials of the invention for insulations and
cable sheaths and for conductor coverings serving both as an
25 insulation and a sheath, at the end of the test carried out,
it was found that only a 20 cm tract of the whole bundle of
cable lengths resulted as being burnt.

30 TESTS FOR DETERMINING THE DIELECTRIC PROPERTIES

These tests were performed for determining the values of
the insulation constant K_i for the materials forming insula-
tions and cable sheaths and conductor coverings serving both
as an insulation and a sheath, namely in the case of materials
35 according to the invention, and of known materials.

1 The tests were performed according to the CEI STANDARDS 2019,
that foresee the immersion of 5 meter long cable lengths into
a container full of water, with applying a D.C. voltage com-
prised between 300-500 Volts between each cable and the water
5 which, in particular, has a temperature of 20°C. Thereafter
the resistance of the insulation is measured, after 1 minute
from the application of the voltage.

10 The results obtained from this test are given in the table
herebelow:

	Ki
15 Compound according to the invention used for conductor coverings serving both as insulation and sheath	100 M Ω /Km
Known compounds used for a conductor covering serving both as insulation and sheath	1 M Ω /Km

20

Where:

Ki is the insulation constant.

25 From examining the tests carried out it can be seen clearly
that, with the materials for cable insulations, for cable
sheaths, and for the conductor coverings serving both as an
insulation and a sheath, according to the invention, and
with the electric cables, according to the invention, the
proposed aims are achieved.

30

In fact, as far as concerns the capacity of producing trans-
parent furmes in case of a fire, there is noted a considerable
increase of about 50% of the transparency obtained with the
materials according to the invention with respect to the
35 known materials and the known cables.

1 Moreover, as far as concerns the capacity for preventing
flame propagation in case of a fire, in the case of the
cables provided with insulations and sheaths according to the
invention, the improvement obtained results as being extremely
5 efficacious.

Probably, one explanation of the causes on the basis of
which it is made possible to obtain such exceptional improve-
ments in the property for resisting the propagation of flames,
10 can be found in the particular characteristic of the magnesium
hydroxide used in combination with the particular type of
polymer base of the compound itself.

In fact, said magnesium hydroxide presents with respect to
15 aluminium hydroxide, which is the known charge to be added to
compounds for forming insulations and electric cable sheaths
whenever a resistance to flame propagation is desired, apart
from the transparency in the fumes emitted, also a consider-
ably higher decomposition temperature.

20 In fact, the temperature of decomposition, i.e. the temperature
at which aluminium hydroxide becomes transformed into a
aluminium oxide with liberating water and absorbing heat,
ranges between 200/250°C, whereas the temperature of de-
25 composition for the magnesium hydroxide, that gives place
to the formation of magnesium oxide and water with the
absorption of heat, ranges between 350/400°C, i.e. it is a
considerably higher temperature with respect to that re-
quired for the decomposition of aluminium hydroxide.

30 Furthermore, the pyrolysis of the polymer base of the
compound according to the invention takes place at a
temperature which is the temperature of decomposition of
the magnesium hydroxide. Hence, these two reactions take
35 place practically simultaneously with thus impeding any

1 combustion taking place, in a way that is more efficacious.

Moreover, as far as concerns the improvements obtained in the dielectric properties of a cable obtainable with the materials
5 used for insulations and sheaths, and conductor coverings according to the present invention with respect to known materials, an explanation for this can be found in the fact that the magnesium hydroxide is a charge that is less polar than aluminium hydroxide, and a reduction in polarity of the
10 material forming the insulation and a sheath, acts in the sense of enhancing the dielectric properties of the latter.

Although there has been illustrated and described here one particular form of realization according to the present in-
15 vention, what must also be intended as comprised within its ambit, are all those possible alternative variations that are available to a technician of the field.

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1 C L A I M S:

1. Material for insulations and sheaths of electric cables,
and for conductor coverings that serve both as an insulation
5 and a sheath,

characterized by the fact of comprising a compound based on
a copolymer, the monomers of which are ethylene and an ester
containing at least one double bond, in which compound there
is present magnesium hydroxide as one component thereof.

10

2. Material according to claim 1,
characterized by the fact that the magnesium hydroxide is
present in a quantity comprised between 75 and 300 parts by
weight with respect to 100 parts by weight of the polymer base.

15

3. Material according to claim 1,
characterized by the fact that the copolymer base of the
compound is ethylene vinyl acetate.

20 4. Material according to claims 1 and 2,
characterized by the fact that the compound that constitutes
it, has the following composition:

	ETHYLENE VINYL ACETATE	100	parts by weight	
	MAGNESIUM HYDROXIDE	170	" "	"
25	CARBO IMIDE	3,8	" "	"
	VINYL TRIMETHOXY ETHOXY SILANE	1,8	" "	"
	STEARIC ACID	2,3	" "	"
	2-4 POLYMERIZED HYDROXY QUINOLINE	1,5	" "	"
	PARAFFIN WAX	2,3	" "	"
30	DICUMYL PEROXIDE	3	" "	"

5. Electric cable comprising a conductor and at least one
insulation or a covering serving as an insulation and a
sheath,

35 characterized by the fact that said insulation or covering
is a copolymer base compound, the monomers of which are

1 ethylene and an ester containing a double bond, that
compound containing magnesium hydroxide as one component
thereof.

5 6. Electric cable according to claim 5,
characterized by the fact of comprising a sheath constituted
by a compound having a copolymer base, the monomers of which
are ethylene and an ester containing at least one double
bond, that compound containing magnesium hydroxide as one
10 component thereof.

7. Electric cable according to claims 5 and 6,
characterized by the fact that the magnesium hydroxide in
the compound is present in a quantity comprised between
15 75 and 300 parts by weight with respect to 100 parts by
weight of the base polymer of the compound.

20

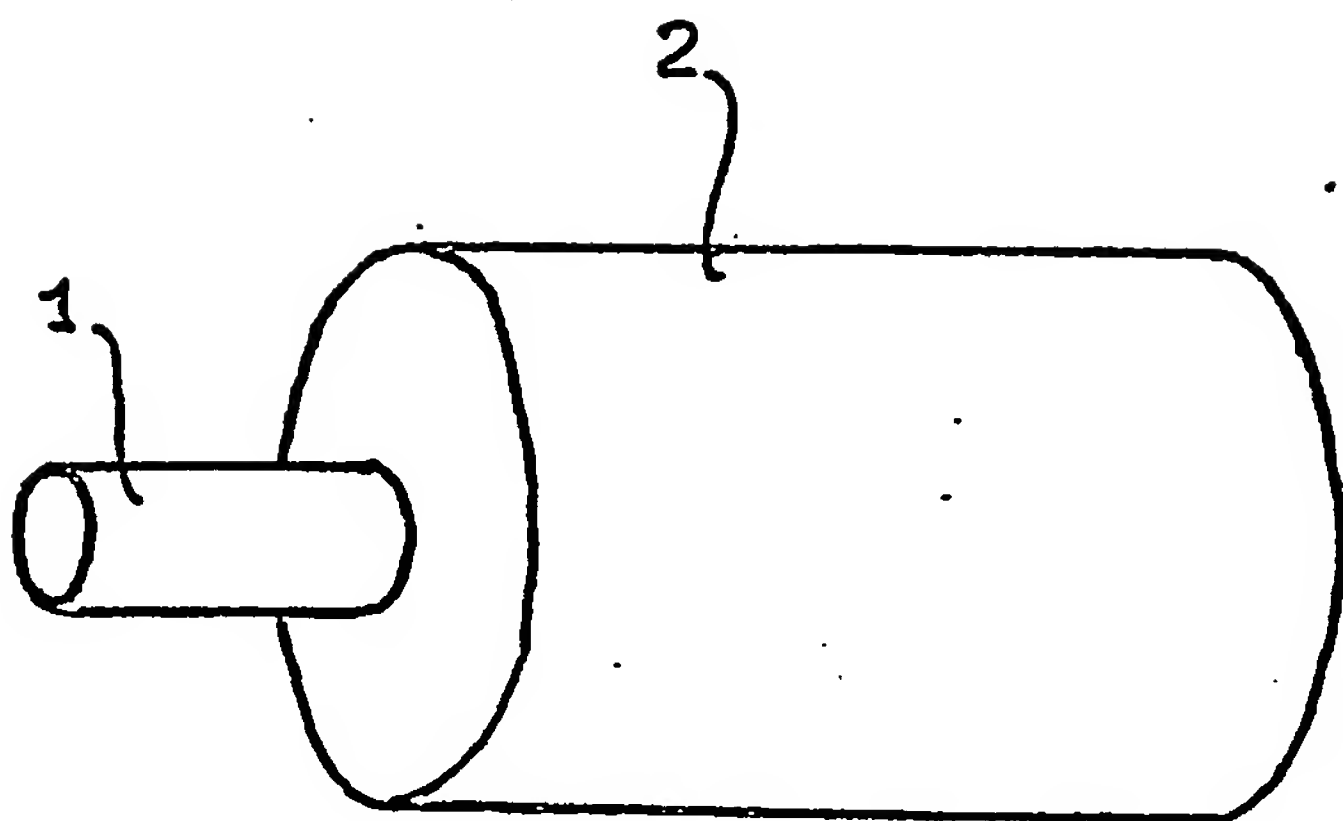
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EUROPEAN SEARCH REPORT

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Application number

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 3)
A	FR-A-2 450 851 (GENERAL ELECTRIC)		H 01 B 3/44 C 08 L 23/08
A	--- CHEMICAL ABSTRACTS, vol. 82, no. 2, 13th January 1975, page 30, no. 5009n, Columbus, Ohio, US & JP - A - 74 13 616 (MITSUBISHI PETROCHEMICAL CO., LTD.) 02-04-1974		
A	--- CHEMICAL ABSTRACTS, vol. 93, no. 4, 28th July 1980, page 40, no. 27350w, Columbus, Ohio, US & JP - A - 80 34 226 (FURUKAWA ELECTRIC CO., LTD.) 10-03-1980		
A	--- CHEMICAL ABSTRACTS, vol. 91, no. 22, 26th November 1979, page 33, no. 176197n, Columbus, Ohio, US & JP - A - 79 77 658 (MITSUBISHI PETROCHEMICAL CO., LTD.) 21-06-1979		TECHNICAL FIELDS SEARCHED (Int. Cl. 3) H 01 B 3/00 C 08 L 23/00
A	--- CHEMICAL ABSTRACTS, vol. 90, no. 22, 28th May 1979, page 51, no. 169670n, Columbus, Ohio, US & JP - A 78 147 745 (SHOWA ELECTRIC WIRE AND CABLE CO., LTD.) 22-12-1978 -----		
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 18-11-1983	Examiner STIENON P.M.E.
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			